



National Seasonal Assessment Workshops

Western States & Alaska

April 4–7, 2006
Boulder, Colorado

Eastern, Southern, & Southwestern States

January 17–20, 2006
Shepherdstown, West Virginia



**Final Report
June 2006**

**Ben Crawford,
Gregg Garfin,
Rick Ochoa,
Robyn Heffernan,
Tom Wordell,
and Tim Brown**

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Foreword

This volume includes proceedings from two workshops to assess pre-season fire potential for the United States. The National Seasonal Assessment Workshop for the Eastern, Southern, and Southwest Geographic Areas was held January 18–20, 2006, in Shepherdstown, West Virginia. The National Seasonal Assessment Workshop for the Western States and Alaska was held April 4–7, 2006, in Boulder, Colorado. Both workshops brought together predictive services wildland fire analysts, fuels specialists, fire intelligence personnel, and meteorologists, with climatologists from regional and national research institutions and operational forecast entities. Both workshops expanded on activities and achievements from previous years, including training and discussion of mutual benefit to predictive services' geographic area personnel and climate scientists. The volume is divided into two major sections, one devoted to each of the workshops.

In January, the Southwest Geographic Area (GA) joined the workshop for the eastern half of the country, due to the fact that the fire season in the southwestern United States can begin as early as late January—when the Southern Geographic Area is often in the early part of its fire season. Southwest GA participation helped to synchronize outlooks across Texas (which was in the midst of record fire activity), and contributed to improved understanding of climate conditions along the southern tier of the United States. Participants from the Eastern and Southern Geographic Areas improved upon the quality of their outlooks by adding new assessment and forecast tools, as well as through improved communication with fuels experts throughout their GAs.

In addition to the fuels and climate forecast discussions, the January 18–20, 2006 National Seasonal Assessment Workshop included training and discussion on teleconnections relevant to the eastern half of the United States, and on the CHEETAH fire analysis and data management tool. NOAA Climate Prediction Center (CPC) climate forecaster Ed O'Lenic brought GA fire meteorologists up to speed on the use of CPC online climate forecast tools and forecast briefing analyses. O'Lenic also presented workshop participants with the latest information on El Niño-Southern Oscillation status (Note: eastern Pacific Ocean temperatures were rapidly approaching official La Niña status during the

mid-winter). Participation by O'Lenic and NWS fire weather expert Heath Hockenberry enhanced connections between the National Interagency Coordination Center (NICC) and NOAA fire weather programs. Workshop organizers have identified improved dialogue and coordination between NICC and NOAA fire weather programs as a goal for future workshops.

In April, participants in the workshop for the western states and Alaska were better prepared than in previous years, and completed detailed assessments in record time. The Southwest GA updated their January assessment, and contributed to synchronizing fire potential assessments with the adjacent southern California (South OPS), Eastern and Western Great Basin, and Rocky Mountains Geographic Areas. The 2005–2006 winter climate pattern over the western United States, with relatively wet conditions over the northern tier and Sierra Nevada and exceedingly dry conditions over the southern tier, dictated much of the apprehension about high fire potential and resource needs for the southern half of the West. Insect-ravaged forests and above-average temperatures are key concerns for Alaska.

The 2006 western workshop climatology training addressed the use of CPC online climate forecast tools and forecast briefing analyses (David Unger, NOAA CPC), as well as sub-seasonal forecasts (Ed Berry, National Weather Service). David Gutzler (University of New Mexico) briefed fire meteorologists on the climatology of the North American monsoon, and efforts to improve monsoon predictions. Gutzler's presentation met a long-standing request for in-depth background and information on the monsoon. Matt Jolly (USDA Forest Service, Rocky Mountain Research Station) oriented all participants to products for interpreting vegetation status from remotely sensed imagery; a highlight of Jolly's presentation was his focus on the proper interpretation of these widely available images for assessing fire potential. Jolly's presentation addressed a request from the 2005 NSAW: Western States & Alaska.

An exciting aspect of the 2006 National Seasonal Assessment Workshop: Western States & Alaska was the addition of participants from Canada and Mexico. Our international colleagues were invited as part of an experimental pilot project to create preseason fire



potential assessments for North America. Their substantial contributions to the workshop included discussion of alternative forecast and assessment methodologies, information about forest and range conditions, fire management techniques and protocols, and improved cross-border communication about the fire-climate nexus. Colleagues from all three countries expressed tremendous interest in a follow-up workshop in 2007. The need for mutually acceptable high-level official protocols between nations, and between agencies within nations, precludes us from presenting the Canadian and Mexican fire potential outlooks in this document. However, securing official sanction for a widely

distributed North American fire potential assessment from the necessary agencies and governments is a high priority for the upcoming year.

I would like to extend my sincere thanks to workshop co-organizers Robyn Heffernan, Tom Wordell, Rick Ochoa, and Tim Brown. Special thanks to lead author Ben Crawford and all of the participants in and contributors to the 2006 National Seasonal Assessment Workshops.

Gregg Garfin
May 2006

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Western States & Alaska

**April 4–7, 2006
Boulder, Colorado**



Sponsors

Western States and Alaska Fire Season 2006

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- Bradley Udall, Western Water Assessment
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Executive Summary

Western States and Alaska Fire Season 2006

Above-normal fire potential is predicted for much of the interior West, Southwest, and Alaska this spring and summer, according to expert assessments from climatologists, meteorologists, fuel specialists, and intelligence personnel. During the fourth annual National Seasonal Assessment Workshop: Western States & Alaska, held April 4–7, 2006, at the NOAA Earth System Research Laboratory in Boulder, Colorado, a map was produced highlighting areas of fire potential for the 2006 fire season (Figure 1, page 17). Fire potential is the likelihood of wildland fire events influenced by factors including fuel conditions, weather, climate, and firefighting resource capability. This report is a synopsis of their findings. Complete geographic area reports are available at: <http://www.nifc.gov/nicc/predictive/outlooks/outlooks.htm>. Updated assessments will be issued throughout the fire season.

Critical Factors

Winter 2005–2006 conditions were characterized by above-normal precipitation and snowpack in the northern half of the western states, which has mitigated fire potential in higher elevation timbered areas (Figure 4, page 19). Conversely, dry winter conditions in the Southwest and western Alaska have created an increased potential for wildfires this spring and summer (Figure 4, page 19). Other critical factors include:

Carryover herbaceous fuels

Abundant standing dead grasses remain from the wet 2004–2005 winter in many parts of the lower elevation Southwest and Great Basin geographic areas. These fine dead fuels increase susceptibility to ignition and provide a continuous fuel bed for rapid fire spread.

Drought

Portions of the West and Alaska remain in drought with depleted soil moisture, lower live fuel moisture, and increased vegetation stress (Figure 5, page 20). This, combined with observed warmer-than average seasonal temperatures, has resulted in increased susceptibility to insect infestation and associated vegetative mortality.

Climate outlooks

For spring and summer, increased chances of warmer-than-average temperatures are predicted for much of the West and Alaska (Figure 3, page 18). Increased

chances of below-average precipitation are predicted for the Southwest this spring and for the Northwest this summer (Figure 3, page 18). Additionally, some climate indicators suggest an early and strong monsoon.

Geographic Area Reports

Alaska

Above-normal fire potential is expected in western Alaska due to low snowpack and warmer-than-normal temperatures this spring and summer. In the Kenai Peninsula, large areas of bug-killed spruce will increase fire risk.

Pacific Northwest

Washington and Oregon have received well above-average precipitation through the 2005–2006 winter. Normal fire potential is forecast for much of the area. Southeast Oregon and north-central Washington are the only areas expected to be above normal. A heavy mountain snowpack could delay the onset of the fire season.

Northern Rockies

Normal spring and early summer fire potential is forecast based on above-average precipitation this winter and predicted drier-than-average precipitation this summer.

Rocky Mountains

Above-average fire potential is expected in the drought-stricken southern Rockies and central Plains. The northern Colorado Rockies have received above-average snowpack and fire potential is forecast to be below normal.

Great Basin

Above-average precipitation throughout the winter in the northern half of the Basin will lead to increased fine fuel loading, resulting in above-normal fire potential below 6,500 feet. Due to drought and carryover fine fuels, above-normal fire potential is anticipated in portions of the southern Great Basin.

Southwest

Fire potential is expected to be above average for most of the area due to a record dry fall and winter. Increased fine fuel loading from record precipitation during the 2004–2005 winter and spring, long-term drought, and widespread vegetative mortality will also contribute to fire risk. There is a possibility for a strong and early monsoon.



California

Below-normal fire potential is expected in portions of northwest California and the Sierra Nevada due to above-normal precipitation and snowpack this winter and spring. Normal fire potential is forecast elsewhere. A later-than-normal fire season onset is also expected.

The Value of the Workshop

These annual assessments are designed to allow decision makers to proactively manage wildland and prescribed fire, thus better protecting lives and property, reducing fire fighting costs, and improving fire fighting efficiency. The 2006 workshop was part of the fourth national assessment organized by the National Predictive Services Group, the Climate Assessment for the Southwest, and the Program for Climate, Ecosystem, and Fire Applications. The first North American Assessment, which included participants from Mexico and Canada, was held in conjunction with this workshop.

Participating Agencies

Alaska Interagency Coordination Center
Bureau of Indian Affairs
Bureau of Land Management
California Applications Program
California Department of Forestry and Natural Resources
Climate Assessment for the Southwest (CLIMAS)/
The University of Arizona
Desert Research Institute

Eastern Great Basin Coordination Center
Lassen National Forest
National Interagency Coordination Center
National Park Service
National Weather Service
NOAA Climate Prediction Center
NOAA Earth System Research Laboratory
Northern California Coordination Center
Northern Rockies Coordination Center
Oregon Department of Forestry
Pacific Northwest Coordination Center
Pacific Southwest Research Station
Rocky Mountain Coordination Center
Rocky Mountain Research Station, Fire Sciences Lab
Scripps Institution of Oceanography
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USDA Forest Service Remote Sensing Application Center
Western Great Basin Coordination Center
Western Water Assessment

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1. Introduction

Western States and Alaska Fire Season 2006

Approximately 50 specialists, including wildland fire analysts, fuel specialists, climatologists, and fire meteorologists from throughout the western United States, Canada, and Mexico met in early April at the National Oceanic and Atmospheric Administration (NOAA) facility in Boulder, Colorado. The purpose of this fourth annual National Seasonal Assessment Workshop was to forecast fire potential for the 2006 season for the western states and Alaska. The fundamental objective of the workshop was to improve information available to fire management decision makers. Ancillary objectives included:

- Improving communication and cooperation between fire professionals and climate scientists.
- Improving interagency and intergovernmental (state, federal) information flow.
- Fostering the exchange of ideas and techniques for assessing fire potential and applying climate forecasts and products to meet fire management needs.

The fire potential forecasting process includes the production of the western forecast and individual Geographic Area Coordination Center (GACC) summaries. Fire potential is defined as the likelihood of wildland fires which are influenced by factors including fuel conditions, weather, climate, and firefighting resource capability. These experts consider a variety of factors when making fire potential forecasts. Fire potential forecasts are primarily based on interactions between climate conditions, fuel types and conditions, long-range predictions for climate and fire, and the persistence of disturbance factors, such as drought- and insect-induced forest mortality.

The workshop included long-range weather outlooks, current geographic area climate and fuel conditions, training, and discussions. Discussion topics included weather and climate forecasts, the North American monsoon, and the use and interpretation of web-based remote-sensing products. International participants, as part of an experimental effort to coordinate fire potential outlooks and information among the United States, Canada, and Mexico, contributed insights about climate and vegetation conditions, and alternative methodologies for assessing fire danger and drought status. They also participated in an additional session to evaluate the process and discuss future joint United States, Canada, and Mexico workshops.

A national map (Figure 1, page 17) was compiled from the Geographic Area fire potential forecasts resulting from this workshop. The forecast map highlights the potential for an above-normal spring and summer fire season in the Southwest, Rocky Mountain, Great Basin, and Alaska areas. Participants also predicted below-normal fire potential for parts of northern California and Colorado because of above-average winter and spring precipitation and snowpack.

Conclusions, along with a description of existing climate conditions and forecasts are included in section two of this report. Complete Geographic Area (Figure 2, page 17) reports are accessible on-line through the website of the National Interagency Coordination Center Predictive Services (www.nifc.gov/nicc/predictive/outlooks/outlooks.htm). Section four of this report includes a brief discussion of recommendations to improve future workshops.



2. Climate Conditions and Forecasts

Western States and Alaska Fire Season 2006

A forecast of fire potential for the West (Figure 1, page 17) was the primary product produced on April 1 by the group of fire and weather/climate specialists gathered in Boulder, Colorado, for the fourth annual National Seasonal Assessment Workshop: Western States & Alaska. Prior to the workshop, participants analyzed fuel conditions and collaborated with field personnel. At the workshop, the attendees studied climate forecasts and impacts for spring and summer and exchanged information on fuels conditions. The group delineated areas of the West likely to face above-average or below-average fire potential. Fire potential is the likelihood of wildland fires based on factors including fuel conditions, weather/climate, and firefighting resources.

The results of the workshop indicated that there is potential for a severe fire season throughout the drought-stricken Southwest, the western Great Plains, and portions of the Great Basin. The concern among workshop participants was supported by the seasonal climate forecasts provided by the National Weather Service's Climate Prediction Center (CPC), International Research Institute for Climate and Society (IRI), and Scripps Institution of Oceanography Experimental Climate Prediction Center (ECPC). A persistent weak La Niña forecast through the spring will continue to affect precipitation and temperature in the western United States.

Fall and Winter 2005–2006 Conditions

The fall and winter of 2005–2006 in the West were characterized by precipitation extremes. The southwestern states experienced one of the driest winter periods on record, while parts of the Northwest experienced record-setting rain and snowfall (Figure 4, page 19). These conditions can be partly attributed to weak La Niña conditions and are a reversal from the previous year when the Southwest had one of the wettest winters on record and the Northwest was unusually dry.

The Southwest has received very little precipitation since the water year began October 1, 2005 (Figure 4, page 19). For example, during winter, Tucson, AZ, received 0.01 inches of precipitation for the driest winter on record. Phoenix, AZ, also set a record of 143 consecutive days with no more than trace precipitation from October 13, 2005 to March 11, 2006. Meanwhile, California, Nevada, Montana, Washington, Oregon,

and Idaho have received above-normal precipitation since October 1 (Figure 4, page 19). This also resulted in above-average snowpack conditions in these regions.

Temperature Forecasts

According to climate forecasts from the CPC, IRI, and ECPC, temperatures in most of the western United States and Alaska are likely to be above average through June (Figure 3, page 18). Areas with the greatest chances for warmer-than-average temperatures include extreme northern Alaska, southern Utah and Nevada, southeastern California, western Texas, and most of Arizona and New Mexico. The exceptions are the northern Great Plains, Rocky Mountains, and Pacific Northwest, which are forecast to have increased chances for cooler-than-normal temperatures for April–June.

The remainder of the summer (July–September) is also expected to be warmer than average for much of the West and Alaska (Figure 3, page 18). For this period, areas with highest probabilities for above-average temperatures have shifted north and west and are centered in southern Nevada and northwest Arizona. No areas are forecast to have cooler-than-average temperatures by the CPC.

Precipitation Forecasts

Currently, conditions in the tropical Pacific show a weak La Niña that is expected to persist through the spring and summer. In the Southwest, typical La Niña conditions are associated with below average winter and spring precipitation followed by an early onset and stronger-than-average monsoon.

Through July, forecasters predict increased chances for below-average precipitation for most of the southern and south-central regions of the country including Texas, Oklahoma, Nebraska, most of eastern New Mexico and Colorado, and southern Nebraska. Greater chances for above-normal precipitation are predicted for North Dakota and eastern Montana (Figure 3, page 18). For the rest of the West and Alaska, forecasters predict equal chances of above-average, average, or below-average conditions.

Forecasts for July, August, and September show a continuing La Niña influence on precipitation in the West. The Southwest, particularly Arizona, is expected to have

above-normal precipitation due to a strong monsoon, while the Northwest, including Idaho, western Montana and Wyoming, and northern California and Nevada, shows increased chances for drier-than-normal conditions (Figure 3, page 18). A stronger than normal monsoon would be welcome in the Southwest given recent drought conditions and the expected severe fire season.

How climate information is used

Meteorologists at the workshop took the climate information about current conditions, forecasts, and scenarios

into consideration when producing the geographic area summaries reported in section three. Fire specialists also contributed important information about where and when specific conditions might be expected to create elevated or reduced fire potential for the coming season.

Fire managers often use fire danger indices such as Energy Release Component (ERC) and fuel moisture values to assist in estimating fire potential. The ERC and fuel moistures in larger dead fuels are good indicators of seasonal fire potential.



3. Summaries by Geographic Areas

Western States and Alaska Fire Season 2006

Alaska

The Alaska fire season for 2006 is expected to be normal in eastern Alaska and above normal in southwest Alaska. This includes portions of the western Kenai Peninsula, where large areas of bug-killed spruce have caused a potential fuels problem, and the area near Delta Junction in the Tanana Valley. This forecast is based on known fuels conditions and snowpack as well as the current seasonal forecasts for the coming summer.

Current Conditions

The snowpack for most of Alaska for winter 2006 is normal to below normal. Deficits in the snowpack occur at lower elevations on the Kenai Peninsula, the McGrath coastal areas, southeastern Alaska, low elevations near Anchorage, and near Delta Junction in the Tanana Valley.

Insect infestation on the Kenai Peninsula has caused more than 1.5 million acres of bug-killed spruce. A similar situation exists in the Copper River Valley. These hazard fuel areas only need the right combination of weather and ignition opportunities to cause large fire problems. Additionally, the Anchorage hillside area has beetle-killed spruce, which creates potential for wildfires in an urban interface area.

Climate and Weather Outlooks

Cooler temperatures forecast by NOAA CPC through mid-April may balance out the meager snowpack in some areas with normal snow-free dates and start of fire season. Current CPC forecasts for the summer call for increased chances of warmer-than-normal temperatures in western and southwestern Alaska and equal chances of above, below, or normal temperatures in the east.

The above-normal temperatures forecast through western Alaska may lead to a busier fire season in the West and Southwest. The challenge in seasonal forecasting in Alaska is to definitively determine the weather features that control the nature and scope of the fire seasons. Although above normal temperatures are forecast over western Alaska this summer, the timing and nature of precipitation and length of dry periods is not known. These variables have a great effect on the fire seasons.

Management Implications/Concerns

Prescribed fire plans should not be greatly affected by

these forecast conditions with the exception of the Delta Junction area where there are planned prescribed fires on military land. The low snowpack may allow these fires to take place earlier when resources are available and not committed to wildfires.

Summary & Recommendations

Given the above conditions and weather forecasts, the area of most significant concern is the western Kenai Peninsula. The combination of below-normal snowpack at lower elevations and the potential for warmer-than-normal temperatures result in elevated fire potential, especially in areas with beetle-killed spruce.

The confidence level of this assessment is moderate. The timing and duration of precipitation and length of dry periods are unknown and greatly influence whether conditions conducive to significant fire growth and an active fire season develop. The lightning season in Alaska does not normally begin until late May and the outlook for lightning occurrence accompanied by dry weather is unknown at this time.

Pacific Northwest

The Northwest Geographic Area appears poised to undergo a normal 2006 fire season for most of the area. Exceptions are the southern Oregon Cascades where abundant winter and spring precipitation and snowpack should delay onset of the fire season at higher elevations. The Okanogan Valley area has potential to have a busier-than-normal fire season owing to persistent drought, particularly at lower elevations. Sections of southeast Oregon are at risk for grassland fires resulting from lightning from monsoonal moisture surges. While winter and spring precipitation are not strongly correlated to subsequent fire season severity, the above-normal values of moisture will likely delay onset of the fire season by about three weeks throughout the region. A shorter season is less likely to be severe.

Current Conditions

- Weak La Niña conditions have had a significant influence across the area during winter and spring resulting in above average precipitation.
- Normal to above-normal precipitation and snowpack exists for most of the area.

- 1,000-hour fuel moistures are at normal to above-normal levels.
- A February dry spell was compensated by heavy January precipitation and near-normal March precipitation, allowing drying fuels to resume accumulation of moisture.
- Precipitation and lightning events during fire season have a stronger influence on fire season severity than antecedent precipitation amounts.
- Fuel moistures in spring appear to be average or above average with no unusually strong drying trends expected before fire season. Extending the above-normal fuel moisture state into the summer results in lower-than-usual fire danger index values.

Climate and Weather Outlooks

- The weak La Niña will continue to influence weather for the next three to six months, but with a weaker influence on the Pacific Northwest weather.
- Below-average temperatures are predicted for Washington and northeast Oregon for April, May, and June. The remainder of the region is expected to experience near-normal temperatures.
- Above-average temperatures and below-average precipitation are forecast for July, August, and September. The temperature outlook is based partly on recently observed trends of warmer-than-average summer conditions.
- A heavier-than-normal monsoon in the desert Southwest is predicted. This could provide wet, rather than dry, type thunderstorms over the Pacific Northwest with a lower risk of excessive fire ignitions over most areas.

Resource Outlooks

The Pacific Northwest is not expected to require an influx of resources. The area is most likely to be an exporter of resources to other areas of the country where higher fire danger may occur. Longer windows for prescribed fire and wildland fire use are possible although the onset of desired conditions will likely be delayed to the cool and wet conditions experienced so far this year.

Future Scenarios/Probabilities

The potential for an active fire season depends upon the severity of drying during the peak months of July

and August combined with the frequency of lightning outbreaks. The forecasted stronger Southwest monsoon may result in more frequent surges of moisture into Oregon east of the Cascades from Klamath Falls to John Day to Baker City. Lightning from these surges may be sufficient to ignite fires that will challenge initial attack in southeast Oregon grassland areas. Surges of monsoon moisture from the south into eastern Washington are expected to be less frequent than those into Oregon.

Assuming normal spring moisture and normal to slightly below-normal precipitation in July, a forecast of a normal fire season seems reasonable. Applying normal trends to Oregon fuel moistures indicates that moistures would not be below critical levels typically associated with large fires. Critical fuel moisture levels in May and June associated with large fires are:

- North Cascade: May 26 percent and June 23 percent;
- Southwest Oregon: May 18 percent and June 14 percent;
- Northeast Oregon: May 14 percent and June 13 percent;
- Central Oregon: May 14 percent and June 12 percent.

Management Implications/Concerns

There are no significant management implications under the expected scenario. A shorter fire season may result in fewer resource needs with at most a normal complement of resources being used. The region may be a source for resources for other areas of the country that may experience high fire activity.

Summary & Recommendations

The Pacific Northwest experienced a wet winter and early spring with an abundant snowpack in part due to weak La Niña conditions. This moisture tends to delay the onset of fire season by about three weeks. Fuels that dried during a February dry spell re-accumulated moisture during March and early April. There are no expected strong anomalous weather conditions during the fire season that would create fire management problems. The desert Southwest monsoon may be active which could result in surges of moisture from the south that produce thunderstorms with moisture in an area extending primarily from Klamath Falls to John Day to Baker City. Less frequent southerly surges would extend into eastern Washington.

Confidence in precipitation forecasts this far in advance must be assessed as low. A better picture of the



upcoming season will be available at the end of May and this assessment will be updated accordingly.

Northern Rockies

The Northern Rockies Geographic Area should enjoy a normal 2006 fire season based on current and historical conditions. It should be noted that there are a myriad of factors affecting the total number of fires, acres, and firefighting resources used which cannot be predicted with any confidence this far in advance.

A typical fire season begins mid- to late June and lasts until a normal season ending event by mid-September. In the plains of eastern Montana and North Dakota there is a late fire season in late fall associated with strong wind events.

Current Conditions

- The weak La Niña has had a significant influence across the area in terms of above-average precipitation;
- Temperatures are generally above normal throughout the area;
- There is normal to above-normal precipitation and snowpack for most of the Area;
- This is the eighth year of drought conditions;
- 1,000 hour fuel moisture is at normal levels;
- Beetle kill acreage has increased;
- Fuel loading continues to be heavy.

Climate and Weather Outlooks

- Below-average temperatures and normal precipitation are predicted for April, May, and June;
- Above-average temperatures and below-average precipitation are predicted for July, August, September;
- A weak La Niña will continue to influence weather for three to six more months;
- There will be abundant fine fuels in response to winter and spring precipitation;
- Prescribed burning may be hindered by a wetter-than-average spring;
- A heavy snowpack may delay onset of fire season, especially at higher altitudes.

Future Scenarios/Probabilities

The potential for an active fire season depends largely on how much moisture is received in spring and the amount of precipitation in July. Normal to above-normal moisture typically produces a normal to below-normal fire season. Below-normal moisture tends to produce an above-normal potential for a large fire season.

Summary & Recommendations

Assuming normal spring moisture and normal to slightly below-normal precipitation in July, a forecast of a normal fire season seems reasonable. Confidence in precipitation forecasts this far in advance must be assessed as low. A better picture of the upcoming season will be available at the end of May and this assessment will be updated accordingly.

Rocky Mountains

Current Conditions

- Severe to extreme drought conditions in southern Colorado through winter and fall 2005–2006;
- Moderate to severe drought conditions in the front range and western central plains through winter and fall 2005–2006;
- Below-average snowpack in southern Colorado;
- Below-average snowpack in the front range and western central Plains;
- Above-average snowpack in the northern Rockies.

Climate and Weather Outlooks

- La Niña conditions will continue to influence climate, mostly likely suppressing precipitation in the area. Forecasters predict increased chances for below-average precipitation in the area;
- Above-normal temperatures and below-normal precipitation are forecast through summer.

Summary & Recommendation

- Southern Rockies: above-normal fire potential;
- Front Range and western central Plains: above-normal fire potential;
- Northern Rockies: below-normal fire potential;
- Elsewhere: normal fire potential.

Great Basin

Current Conditions

Above-normal precipitation over the last two years has largely eliminated drought conditions in the Great Basin. A cool and wet spring has left much of the northern half of the Great Basin with high soil moistures and a potentially significant grass fire problem. A heavy snowpack in the mountains should last well into late spring/early summer, insulating timber fuels from fire activity until late in the summer and decreasing chances of large timber fires (greater than 1,000 acres) for the entire fire season. A weak La Niña, which contributed to precipitation across the Great Basin last winter, is expected to steadily decrease as summer approaches, and should have little influence on the coming fire season.

Future Scenarios/Probabilities

Northern Nevada

In northern Nevada, high fire potential is forecast primarily in the lower elevations. Exceptional precipitation from December 2005 to early spring 2006 across the area has created two radically different fire scenarios depending on elevation. High elevation areas across Northern Nevada are currently carrying 120 percent to 150 percent or more of normal snowpack. This snow, combined with higher-than-normal soil moistures, should strongly decrease chances of fire in mountain areas (specifically elevations above 6,000–6,500 feet). In the lowlands, where a significant grass crop has carried over from last year, this winter's precipitation and high soil moisture will contribute to a heavy and continuous growth in cheat grass, a prime fuel for fast-moving fires. A particularly troublesome area will be the foothills of the Sierra Nevada. Even through most of the Sierra will have below normal fire potential, the foothills will benefit from snowmelt with an abundant grass crop. As this grass cures mid-summer, a strong wind event could push a Sierra foothills fire to several thousand acres.

Central and Southern Nevada

Two areas of central and southern Nevada will also have above-normal fire potential: Mount Charleston (typically an area of high lightning occurrence) and the far eastern mountains near Caliente and Pioche (north of last year's Southern Nevada Complex), where near-normal precipitation and high soil moistures will contribute to another area of heavy grass growth.

Eastern Great Basin

March snows flattened most carryover grasses in western and southeastern Utah and southern Idaho, but a good winter crop in west central and southeast Utah and spring emergences will add to carryover that remains standing. It is not likely that fuel loadings will reach the near record levels of 2005 but they will increase fire potential once again. Below-average snowpack in the southern Utah mountains should contribute to an increase in fire activity from last year when large fuels remained wet from near record snows.

Consequently, the 2006 fire potential is forecast to be above normal across most of the grasslands below 7,000 feet in western and southeastern Utah and the central and lower Snake River Plain in Idaho.

Management Implications/Concerns

Eastern Great Basin:

- Prescribed fire operations in the western deserts of

Utah and the central Snake River Plain of Idaho, where carryover fine fuels were not flattened by snow, could benefit from an emerging new crop of grasses which will help reduce fire activity. However, a dry and windy period could cause fire control problems even in green-up.

- There could be an active grassland wildfire season once fine fuels are cured.
- There is likely to be an increase in timber fire in far southern Utah after a relatively inactive season in 2005. This may create a strain on resources if coincident with an active grassland season.

Western Great Basin:

- Wet and green fuels for the next 30–60 days will reduce the risk of escapes from any prescribed fire activity. By late spring the prescribed fire activity window will begin to close as the annual fine fuels begin to cure.
- An active grass fire season will likely cause moderate to heavy resource demand across northern Nevada beginning as early as June and continuing throughout the summer into the early fall months.

Southwest

The primary 2006 Southwest Area fire season will be above normal in terms of the geographic area's impact on national firefighting resources. This will be characterized by a season of near-normal onset and duration, but of unusual intensity and scope during May and June. Fire potential is expected to be above normal across all elevations and fuel types over the majority of the geographic area during this time frame, with elevated initial attack and large fire development. The potential for fires in the timber fuel types will be particularly high relative to normal. Overall confidence in this forecast is high, mainly due to the overwhelming nature of the current fuels conditions and lack of a climate prediction scenario that could significantly change them.

Current Conditions

- Recent moisture and an active storm track through much of April will delay the active fire season until May and cause green-up of fine herbaceous fuels across a significant portion of the area.
- The combination of above-normal precipitation in 2005 and longer term drought over the past seven years has resulted in an above-normal amount of



carryover fine fuels and below-normal fuel moisture values in existing dead and live fuels.

- Precipitation was well-below-normal over the 2005–2006 winter, with a present average regional River Basin Snow Water content value of 22 percent.
- Approximately 221,000 acres have burned in the Southwest, mostly in southern Arizona and eastern New Mexico.
- In terms of current and forecast conditions, the year 1996 is the most similar to what is expected in 2006.
- A notable difference in the comparison between 1996 and 2006 is that significantly less fire activity is expected this April due to periodic moisture with storm systems continuing to move through the area.

Climate and Weather Outlooks

- May and June are forecast to be warm to hotter-than-normal and drier-than-normal.
- Moisture is predicted to increase east of the continental divide by late May/early June.
- The monsoon is expected to begin early or on time and provide ample rainfall.
- Climate outlooks call for an extension of weak La Niña conditions through much of the spring. This supports the forecast for an overall dry spring, and could lead to an enhanced or early monsoon onset.

Resource Outlooks

- Overall resource needs in terms of national resources (Type I crews, air tankers, Incident Management Teams, etc.) to support project fire activity are forecast to be above average, with additional initial attack and extended attack resources likely required for the timber regimes across much of the region.
- Using 1996 as an analog and accounting for significant differences, the following are expected for the 2006 season.
 1. Fire activity will be confined to southern Arizona, southern and eastern New Mexico and West Texas through April, then shift rapidly to encompass most of Arizona and New Mexico during May and June.

2. About 17 large fires will require one or more Type I or II Incident Management Teams compared to the average of 14.
3. The total number of fires is expected to be 10 to 15 percent more than usual.
4. The total number of acres is expected to be 0 to 40 percent more than usual.

- Expected fires and acres estimate April–June 2006*

<i>Southwest Area</i>	<i>Total Fires</i>	<i>Total Acres</i>
Total Fires & Acres	2,256	178,142
Average ('90–'05)	2,061	177,266
Median ('90–'05)	1,949	127,209
Percent of Average	109%	100%
Percent of Median	116%	140%

- * *Note: Estimates based on 1996 fire statistics for April through June, as adjusted for 2006. Also note that approximately 221,000 acres were reported burned in the Southwest Area from January–March 2006.*

Future Scenarios/Probabilities

- Fire activity will remain significant through mid-July west of the Continental Divide.
- In mid- to high-elevation areas, heavier fuel types will support significant fire activity by May.
- Lightning initiated fire activity is expected to be high when atmospheric moisture levels rise.
- Critical (ninetieth percentile or higher) area average energy release component (ERC) values are expected to occur from around early May through early July (8–10 weeks). Historical maximum average ERC values will be challenged, if not reached, from mid-May to mid-June.

Management Implications/Concerns

Prescribed fire activity was frequent due to the warmer- and drier-than-normal 2005–2006 winter. With fewer storms or strong winds, burn projects could be more aggressive.

Summary & Recommendations

The year 2006 is shaping up to be a very active and intense fire season, with a near-normal duration and onset.

California

This fire potential outlook is based on past developments, current conditions, trends, and predictions for the next six months (April through September), prior to the significant weather months of April and May. Therefore, while it should aid California wildland fire managers in 2006 fire season preparedness and add early insight, the outlook is not the final word. A more comprehensive California Seasonal Fire Weather/Fire Danger Outlook will be published in separate North Ops (Northern California GACC) and South Ops (Southern California GACC) documents, which will come by late June and the end of May, respectively. These documents will give increased detail regarding all aspects of the coming fire season and will provide any necessary updates to the July through October climate forecasts used at the writing of this report. In addition to this outlook, the GACC Predictive Service Units issue detailed monthly assessments of fire weather and fire danger.

Current Conditions

La Niña conditions which developed rapidly this past winter and peaked near moderate strength in February resulted in varying precipitation amounts across the state. In North Ops, precipitation through February ranged from 70 percent of normal in the south to 140 percent of normal in the north. By March, a shift to a very wet and cool pattern occurred and brought near record breaking snowfall across the higher elevations for the month. Currently, North Ops has received 120 to 200 percent of normal precipitation, with the mid- to high-elevation snowpack much above average.

The bulk of the cool season has been much drier in southern California, with precipitation amounts varying generally between 50 percent of normal in the south to a little more than 120 percent of normal across the central portions of the state. Recent rains over the last four to six weeks have alleviated some of the drier conditions across southern portions of California.

Dead fuels are currently either snow-covered or have moisture contents near to above normal, especially in the northern two-thirds of the state. A continuing area of concern is the large amount of bug-killed timber on the national forests from about the Sequoia southward. The arrangement of these fuels is changing from aerial to surface as dead trees continue to fall. Snowpacks and continued wet weather will delay green-up dates for live

fuels, particularly at mid- and upper-elevations. One effect will be that live fuel moistures will remain at high levels longer into the fire season than normal.

Climate and Weather Outlooks

Above-normal rainfall and below-normal temperatures will continue across much of California through at least late April. A transition to a warmer and drier pattern, relative to normal, is anticipated to occur sometime in May. Near-normal temperatures and precipitation are then expected statewide for the latter half of May and into June, with the possibility of North Ops rising to a few degrees above normal. For the summer period, a continuation of near-normal temperatures is expected in the coastal areas, but the interior portions of the state will likely experience near to slightly above-normal temperatures. For this period, precipitation is forecast to be at or a little below normal, but it should be noted that average rainfall during the summer for much of the state is insignificant. The confidence in these weather forecasts is average.

Future Scenarios/Probabilities

With the recent increase in late season precipitation and delayed green-up, the onset of this year's fire season will generally be later than normal in North Ops and may be later than normal in portions of South Ops. The current and expected weather and fuel conditions will lead to below-normal fire potential over the central and northern Sierras and in portions of northwest California. Near-normal fire potential is expected elsewhere across the state.

Management Implications/Concerns

- With the anticipated later start to the fire season, there should not be a need to bring on resources any earlier than normal.
- California resources will likely be available for out-of-state incidents during the early part of fire season.
- Prescribed burn windows in northern California maybe of normal or longer length, but would start and end later than usual. However, a delayed window will be impacted by potential resource drain to incidents in other regions.
- Funding level reductions could result in diminished initial attack resource capability, thus increasing burned acres to above-average levels.



4. Conclusions and Recommendations

Western States and Alaska Fire Season 2006

The 2006 National Seasonal Assessment Workshop was unique because representatives from Canada and Mexico attended for the first time to learn and share methods for developing fire potential forecasts. A prototype North American fire potential forecast was developed as a result of their collaboration. Protocols need to be developed to implement a North America seasonal fire potential assessment in the future.

U.S. Participant Key Recommendations

- Alaska: better understanding of climate-fire interactions to improve future analysis.
- GIS: enhanced GIS resources and products need to be incorporated in the future.
- Forecasts: more training on how CPC forecasts and associated constituent elements are constructed; more information on teleconnection forecasts and how they relate to temperature and precipitation forecasts.
- Validation: information on climate diagnostics techniques and forecast validation methods is needed to improve post-season evaluation (e.g. Why did the fire season and the year's weather patterns turn out the way they did?)
- Monsoon: more training on monsoon climatology and interannual variations is needed.
- Non-federal partners: greater participation by state, tribal, and other partners would improve future assessments and information flow.
- Hawaii: invite fire and climate specialists from Hawaii to participate in future workshops.
- Online tools for climate and fire analysis: step-by-step training on how to access and use the many climate, vegetation, and fire analysis tools is needed.
- Improved remote access to the workshop: video-conferencing should be explored as an option to increase attendance, especially when scheduling conflicts arise.

5. Figures

Western States and Alaska Fire Season 2006

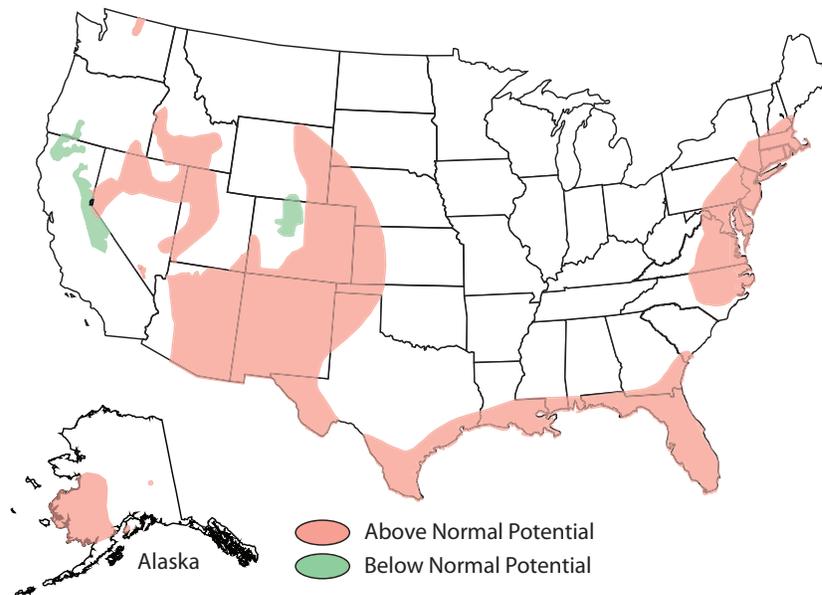


Figure 1. The April–August 2006 outlook for national significant fire potential was produced during the workshop. It highlights areas in the United States that have either above-normal, below-normal, or normal fire potential (white areas) during the coming season.



Figure 2. The western half of the United States is divided into nine Geographic Areas delineated in the map above.

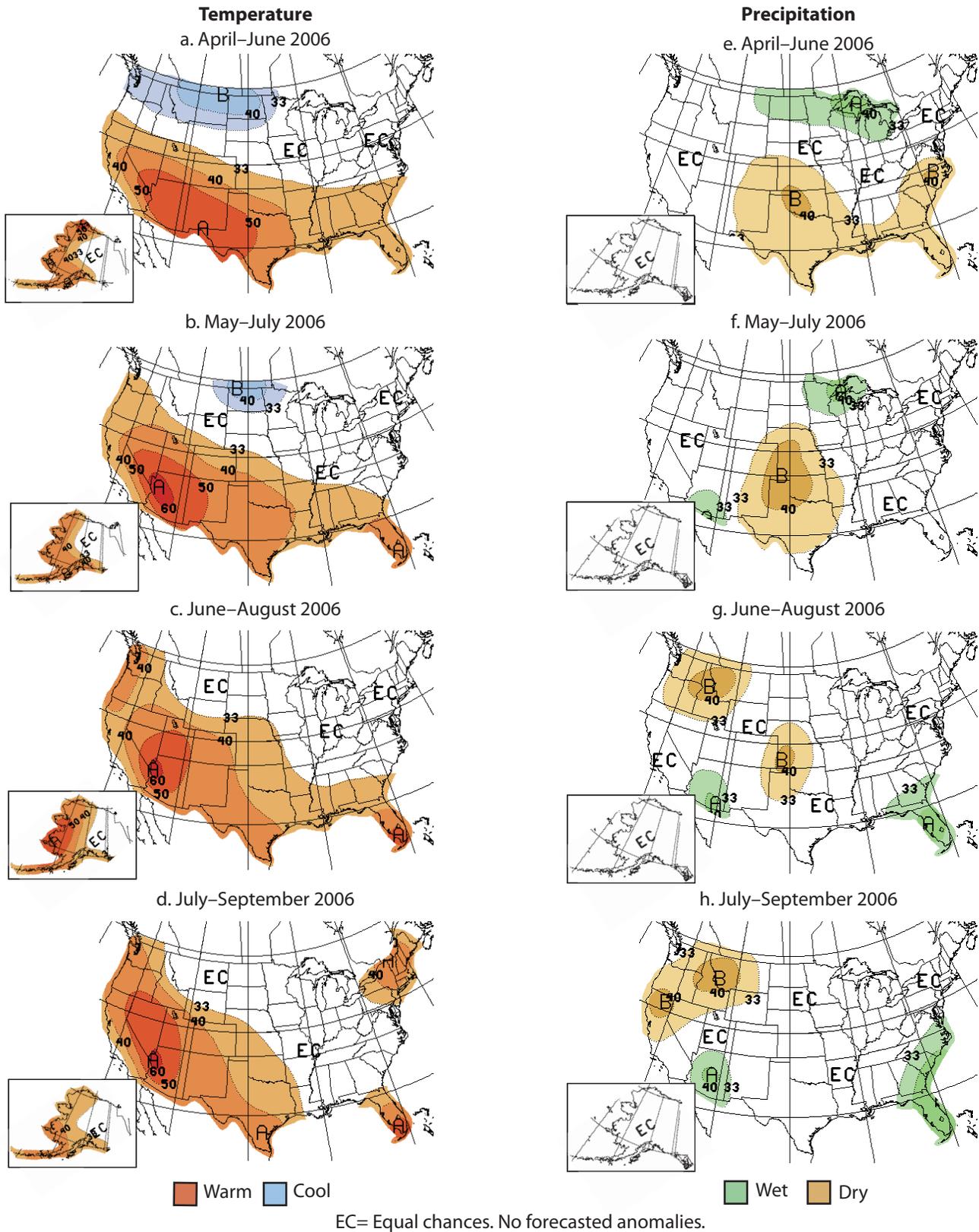


Figure 3a–h. The NOAA Climate Prediction Center (CPC) temperature and precipitation outlooks were used as input to the fire potential outlook during the workshop. The numbers on the maps indicate the probability of an occurrence, while the letters A and B stand for above average and below average respectively.

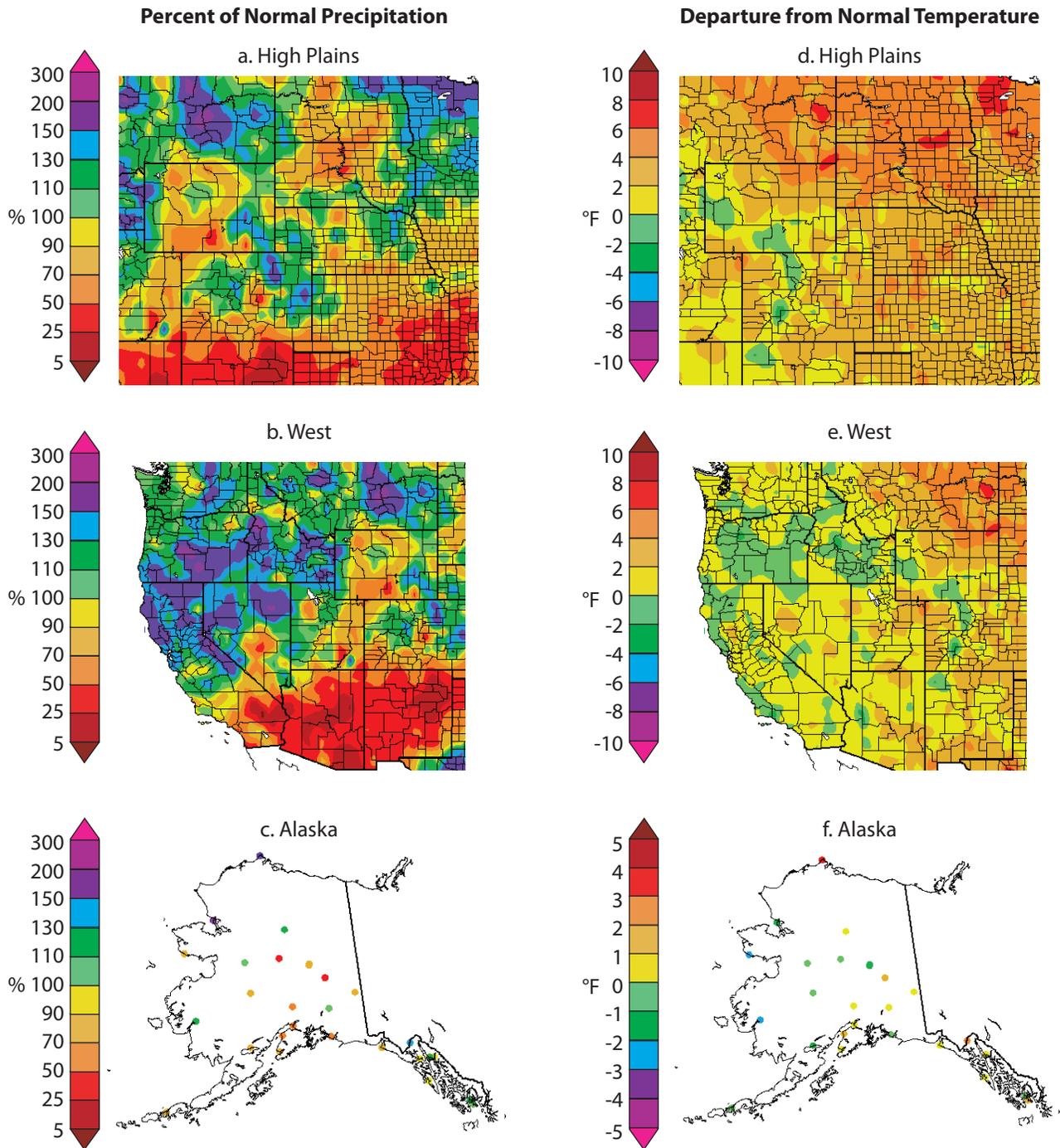
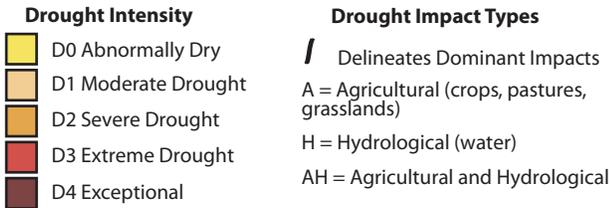
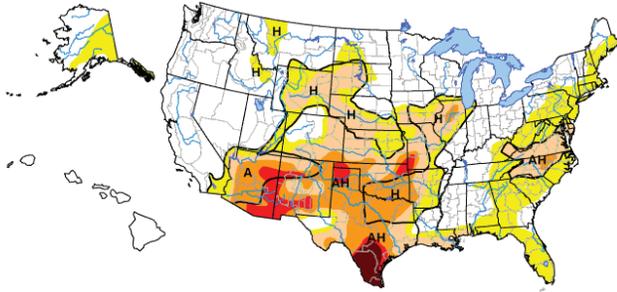


Figure 4a–f. Precipitation and temperature conditions since October 1, 2005, from the High Plains Regional Climate Center. Generally, the Southwest has experienced extremely dry conditions while the Northwest has had above-average precipitation this winter and spring (a–c). Virtually the entire West, except for areas in California, Oregon, and Idaho, and smaller, scattered regions in other states, have experienced above-average temperatures (d–f).



a. U.S. Drought Monitor released April 6, 2006



b. Twelve Month Standardized Precipitation Index

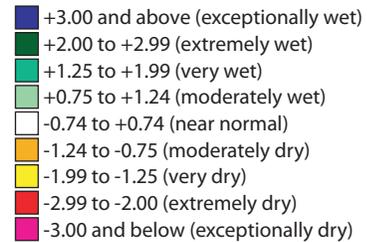
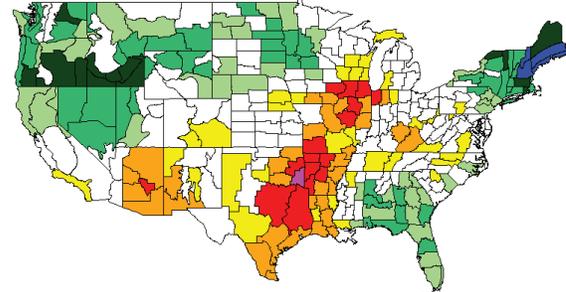


Figure 5a–b. National drought conditions. As of April 6, 2006, extreme drought conditions exist over portions of the Southwest and Rocky Mountain Areas (a). Climate division Standard Precipitation Index (SPI) values for the 12 month period ending February 2006 show wet conditions in the Northwest and dry conditions in the Southwest and Great Plains (b).

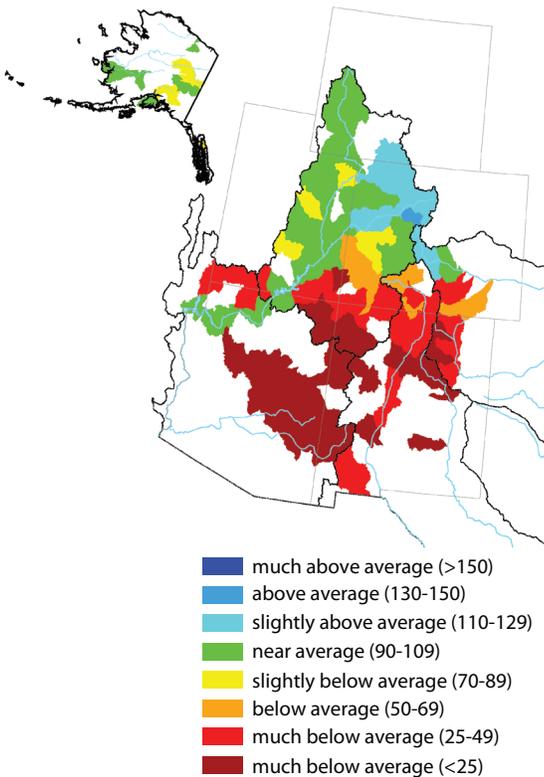


Figure 6. Spring and summer streamflow forecasts as of March 1, 2006 (National Resources Conservation Service) show generally average to above-average streamflow in the Northwest and below-average streamflow in the Southwest. Workshop participants used the March 1 map and data updated through late March.

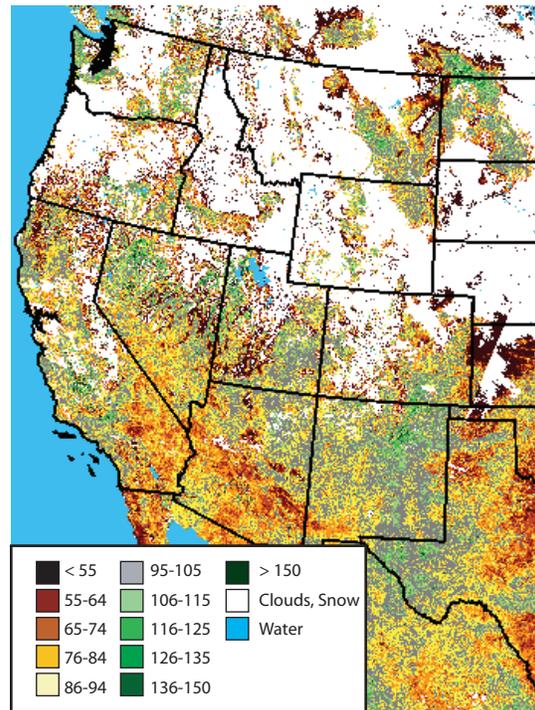


Figure 7. Values (percent of average) for departure from average greenness for March 22–28, 2006. Values are based on satellite measurements of Normalized Difference Vegetation Index.

Appendices

Western States and Alaska Fire Season 2006

Appendix A: Agenda

April 4–7, 2006

NOAA Climate Diagnostics Center
Boulder, CO

Tuesday, April 4, 2006

8:00–8:15 a.m. Greetings and introductions
8:15–9:00 a.m. Remote Sensing products and tools
– Matt Jolly, *USDA-Forest Service, Rocky Mountain Research Station*

Breakout Sessions: *Mets/Climate* *Intel/Fuels*

9:00–10:15 a.m. CPC forecast tools including the Climate Forecast System Discussion
10:30–11:30 a.m. Monsoon
– David Gutzler, *University of New Mexico*
11:30 a.m.–12:00 p.m. Climate and Fire
– Tony Westerling, *California Applications Program, Scripps Institution of Oceanography*
ECPC and OSU
– Tim Brown, *Program for Climate, Ecosystem, and Fire Applications, DRI*

Breakout Sessions end

12:00–1:00 p.m. Working Lunch + 2005 forecast verification – Tim Brown
1:00–1:30 p.m. CPC forecast discussion + Scenario
1:30–2:00 p.m. Canada and Mexico climate
2:15–5:15 p.m. Fuels discussions (including Canada and Mexico)

Wednesday, April 5, 2006

8:00 a.m.–12:00 p.m. Construct outlook (with Mexico and Canada participating)
12:00–1:00 p.m. Lunch
1:00–1:30 p.m. Sub-seasonal forecasting
– Ed Berry, *National Weather Service*
1:30–5:00 p.m. Construct outlook (all)

Thursday, April 6, 2006

8:00–11:00 a.m. United States presentations
11:00 a.m.–12:00 p.m. United States wrap-up discussion (next meeting, format of seasonal product, etc.)
12:00–1:00 p.m. Lunch
1:00–5:00 p.m. Mexico and Canada: construct outlook
United States: travel or complete forecast write-up (optional)

Friday, April 7, 2006

8:00–10:00 a.m. Mexico and Canada presentations
10:00 a.m.–12:00 p.m. Mexico and Canada wrap-up discussion



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Eastern, Southern, & Southwestern States

**January 17–20, 2006
Shepherdstown, West Virginia**

Sponsors

Eastern, Southern, and Southwestern Fire Season 2006

We are grateful to the following institutions and individuals for generously providing funding for the 2006 National Seasonal Assessment Workshop: Eastern, Southern, & Southwestern States.

National Predictive Services Group

USDA-Forest Service.....Neal Hitchcock

National Oceanic and Atmospheric Administration (NOAA)

Climate Program OfficeHannah Campbell and Caitlin Simpson

The University of Arizona

CLIMAS (funded by the NOAA Office of Global Programs).....Gregg Garfin

The workshop was developed and hosted by the following institutions and individuals:

- Tim Brown, Program for Climate, Ecosystem and Fire Applications, Desert Research Institute and California Applications Program RISA
- Gregg Garfin, Climate Assessment for the Southwest, The University of Arizona
- Robyn Heffernan, National Interagency Coordination Center
- Rick Ochoa, National Interagency Coordination Center
- Tom Wordell, National Interagency Coordination Center

Publication of these proceedings was sponsored by:

- Climate Assessment for the Southwest, The University of Arizona
- Institute for the Study of Planet Earth, The University of Arizona
- Climate Program Office, NOAA



Executive Summary

Eastern, Southern, and Southwestern Fire Season 2006

Overview (February–June 2006)

Eastern Area

Significant fire potential is expected for southwestern Missouri, the southwestern Lake Michigan shore west to central Iowa, and northern Illinois. Below-normal fire potential is forecast from the Cincinnati area, extending northeast into New England.

Southern Area

Significant fire potential is expected over the southern Plains, Texas, and much of Florida. Normal potential is forecast for the remainder of the geographic area.

Southwest Area

Significant fire potential is expected for the entire Southwest geographic area, with an earlier-than-normal start to the season. There is a tendency for an early monsoon onset during years with low snowpack.

Fuels

Eastern Area

Dry fuel conditions from recent below-normal precipitation totals extend from southwestern Missouri through Iowa, and into northern Illinois.

Southern Area

Moderate to heavy blowdown from hurricane damage exists along the Gulf Coast from eastern Texas through the western panhandle of Florida, and in portions of southern Florida. Previous hurricane damage and bug-kill have created hazardous fuels throughout much of North Carolina and along the coast of Virginia. Dry fuel conditions over the southern Plains, Texas, and the Florida peninsula have led to an active start to the season.

Southwest Area

An abundance of herbaceous fine fuels remain across much of the Southwest area from the wet winter of 2005. Significant lack of precipitation since fall 2005 has led to extremely low mountain snowpack and very dry fuel conditions across the entire geographic area. These factors are expected to lead to an early start to the fire season, with high likelihood for early season timber fires.

Resources

Eastern Area

No major problems are anticipated and resources should be available to support other areas.

Southern Area

Additional resources may be needed in order to maintain initial attack capability of early season fires across the southern Plains, Texas, and Florida, while at the same time meeting resource needs for prescribed burning. Elevated risk of landfalling hurricanes later in the season may compete with resource needs elsewhere.

Southwest Area

An early and active fire season will require firefighting resources to be trained and available earlier than normal.

Climate Assessment (through mid-January 2006)

Southern Area

The southern area has experienced significant drought west of the Mississippi River Valley. Light-to-moderate drought exists across Kentucky, Tennessee, and western Mississippi. There have been moderate precipitation deficits in central and southern Florida over the last 90 days. The central and western portions of the area have registered consistently above-average temperatures since June 2005.

Eastern Area

As of the workshop, New England has been exceptionally wet during the last 90 days. Temperatures have been above average in the northern tier of the eastern area during the last 30 to 90 days. Consequently, snow depths have been at or below average in the upper Midwest.

Southwest Area

Dry and warm conditions dominated the Southwest since a relatively weak 2005 summer monsoon. The area has experienced exceptional dryness and extremely low snow during the last 90 days.

Climate Forecast

Southern Area

Consistently increased chances of above-average temperatures are expected for the Southwest, Texas, and southern Florida through the early summer. Increased

chances of below-average precipitation are expected for the southern Plains and West Texas through the late winter and early spring, and for Florida through the spring season.

Eastern Area

Increased chances of above-average precipitation are expected for the Ohio River Valley between February and May and for the northern Midwest between late spring and early summer.

Southwest Area

Increased chances of below-average precipitation are expected for the Southwest. Generally, dry conditions are expected in the southern tier of the United States if Pacific Ocean conditions meet the criteria for a La Niña episode.

Workshop Summary

These annual assessments are designed to allow decision makers to proactively manage wildland and prescribed fire, thus better protecting lives and property, reducing firefighting costs, and improving firefighting efficiency and land management objectives.

The 2006 workshop was part of the fourth national assessment organized by the National Predictive Services Group (NSPG); the Climate Assessment for the Southwest; and the Program for Climate, Ecosystem, and Fire Applications.

Participating Agencies

Bureau of Indian Affairs
 Bureau of Land Management
 CLIMAS/The University of Arizona
 COAPS/Florida State University
 Eastern Area Coordination Center
 Florida Division of Forestry
 National Interagency Coordination Center
 National Park Service
 NOAA Climate Prediction Center
 NOAA Office of Global Programs
 Northeast Regional Climate Center/Cornell University
 Southeast Climate Consortium
 Southern Area Coordination Center
 Southwest Area Coordination Center
 U.S. Fish & Wildlife Service
 USDA-Forest Service



1. Introduction

Eastern, Southern, and Southwestern Fire Season 2006

Fifteen specialists, including wildland fire analysts, fuel specialists, climatologists, and fire meteorologists from throughout the Southwest and the eastern half of the United States met in late January at the National Conservation Training Center in Shepherdstown, West Virginia. The purpose of this fourth annual National Seasonal Assessment Workshop was to forecast fire potential for the Eastern, Southern, and Southwest Geographic Areas for the first half of 2006. The fundamental objective of the workshop was to improve information available to fire management decision makers. Ancillary objectives included:

- Improving communication and cooperation between fire professionals and climate scientists.
- Improving interagency and intergovernmental (state and federal) information flow.
- Fostering the exchange of ideas and techniques for assessing fire potential and applying climate forecasts and products to meet fire management needs.

The fire potential forecasting process includes the production of the western forecast and the writing and reporting of individual Geographic Area Coordination Center (GACC) summaries. Fire potential is defined as the likelihood of wildland fire events influenced by factors including fuel conditions, weather, climate, and firefighting resource capability. These experts, in consultation with more than 20 other experts who were unable to attend the workshop,* considered a variety of factors when making their fire potential forecasts. Fire potential forecasts are primarily based on interactions between climate conditions, fuel types and conditions, long-range predictions for climate and fire, and the persistence of disturbance factors, such as drought- and insect-induced forest mortality.

The workshop included one half-day of training followed by one-and-a-half days of preparing fire potential

assessments. Training focused on topics requested at previous workshops, including improved knowledge of NOAA Climate Prediction Center forecasts and constituent forecast tools, climate teleconnection patterns affecting the eastern half of the United States, and multi-decade climate variations.

The main product of the workshop was a map forecasting fire potential for the eastern and southwestern United States (Figure 1, page 17). The map highlights the potential for an above-normal spring and summer fire season in the Southwest, southern Plains and western Gulf Coast, Florida, and a region centered on northern Illinois and eastern Iowa. Major factors contributing to above-normal fire potential included developing La Niña conditions in the Pacific Ocean, which often foreshadow below-average precipitation in the southern tier of the United States, and fuels conditions, including well-cured fine grasses in the Southwest and considerable blown-down timber along the western Gulf Coast and Florida. Below-normal fire potential is forecast for the northeastern United States and upper Ohio River Valley.

Section two includes a summary of conclusions, along with a description of existing climate conditions and forecasts. In addition to producing the forecast map, members of GACCs (Figure 8, page 36) worked together to produce reports of fire potential forecasts by individual area. Full reports are accessible online through the website of the National Interagency Coordination Center Predictive Services (see References), which coordinates the efforts of GACC Predictive Services units. Section four includes a brief discussion of recommendations to improve future workshops.

* *During January 2006, many of the potential participants for this workshop were involved in firefighting activities in Texas and Oklahoma, or in Hurricane Katrina-related support or fuels mitigation projects.*

2. Climate Conditions and Forecasts

Eastern, Southern, and Southwestern Fire Season 2006

A forecast of fire potential (Figure 8, page 36) was the primary product produced on January 20, 2006 by the group of fire and weather/climate specialists gathered in Shepherdstown, West Virginia for the fourth annual National Seasonal Assessment Workshop: Eastern, Southern, & Southwestern States. After analyzing climate forecasts for the late winter through the early summer and exchanging information on climate impacts and fuels conditions, the group delineated the areas of the East, South, and Southwest likely to face above-average or below-average fire potential. Fire potential is the likelihood of wildland fires based on factors including fuel conditions, weather/climate, and firefighting resources.

The results of the workshop indicated that there is potential for severe fire activity throughout the drought-stricken Southwest, the Southern Plains, the western Gulf Coast, Florida, and portions of the country southwest of Lake Michigan. Decreased fire potential for severe fire activity was forecast for portions of the Northeast and Mid-Atlantic states.

Much of the country's midsection, from the Great Lakes states southwest to the Southern Plains (including Arkansas and Louisiana) are in the grip of drought conditions that developed in spring 2005. Precipitation deficits during just the last quarter of 2005 (October–December) were as high as 15 inches in parts of the region encompassing Oklahoma, Texas, Arkansas, and Louisiana. Deficits for calendar year 2005 were greater than 20 inches in that region and in northwestern Illinois. In contrast, the Northeast received above-average precipitation during 2005, and the entire East Coast showed above-average precipitation totals during the last quarter of 2005. During these same time periods, temperatures were normal to above normal in the eastern half of the United States and Southwest, especially during the summer and autumn months.

The oceanic and atmospheric indicators in the tropical Pacific Ocean tended toward weak La Niña conditions between fall 2005 and winter 2006. Sea surface temperatures (SSTs), a sensitive indicator of La Niña conditions, along the equator in the eastern and central Pacific are more than 0.5 degrees Celsius below average from the International Date Line to 100° W. Much of

the region between 175° W and 120° W is more than 1 degree C below average, which also is indicative of La Niña conditions. Other La Niña indicators include below-average ocean temperatures in the eastern Pacific that extend from the surface to more than 150 meters deep. Thus, forecasters expect the pattern of SSTs to persist through at least February 2006. The consensus of several models used at NOAA Climate Prediction Center suggest that weak La Niña conditions, which usually bring drier-than-average winters to the southern tier of the United States, will continue through the early spring. East Pacific SSTs are expected to warm to neutral El Niño–Southern Oscillation conditions during the spring and early summer. The effect of these ocean-atmosphere patterns and long-term trends on future temperature and precipitation is discussed below.

Temperature Forecasts

Substantially enhanced chances of above-average temperatures are predicted for much of the Southwest (Figure 3, page 18) are mainly due to long-term trends, with some enhancements in forecast confidence due to agreement from NOAA's Climate Forecast System and other model's predictions for a region from the Southwest into western Texas. Increased chances of above-average temperatures are predicted for the Mid-Atlantic states for February through April, and for Florida through the spring and early summer. The outlooks for spring 2006 include regions of increased chances of below-average temperatures in the Northern Plains, including Minnesota. Most statistical forecast tools and all dynamical forecast models used by NOAA Climate Prediction Center predict increased chances of below-average temperatures for parts of the northern tier of the United States.

Precipitation Forecasts

There is widespread consensus among models for drier-than-normal conditions over large parts of the southern third of the continental United States (CONUS) for the late winter 2005 and early spring 2006 (Figure 3, page 18). Increased chances of above-normal precipitation for the Ohio River Valley during late winter and spring are consistent with La Niña conditions and are evident in some of the models. Forecasts show increased chances of drier-than-normal conditions in parts of the southern CONUS, including Florida, into spring 2006.



3. Summaries by Geographic Area

Eastern, Southern, and Southwestern Fire Season 2006

Eastern Area

Current Conditions

The Eastern Area report refers to four fire management compacts as shown in Figure 9 (page 36). Overall, the driest parts of the area throughout 2005 were the southwestern, northwestern, and north central Big Rivers as well as southern Wisconsin and southwestern Michigan. The dry areas of the Big Rivers persisted into the 2005–2006 winter season (Figure 10, page 37). Local officials reported that moisture deficits had improved across southwestern Michigan. However, far southern Wisconsin still reported soil moisture (Figure 11, page 37) and precipitation deficits in mid-January 2006.

Much of the eastern two-thirds of the Northeast Compact, as well as the northeastern Mid-Atlantic states, experienced above-average precipitation amounts overall through 2005. Although below-average snowfall amounts and above-average temperatures have prevailed in northern Maine, near- to below-normal large fire potential is anticipated during the spring of 2006.

It is difficult to assess fuel conditions this early in the year. Fire frequency peaks during the spring due to the abundance of fine dead fuels and the absence of live green fuels. These fuels are readily available and are more responsive to short-term weather variations than to seasonal trends; short-term weather variations cannot be reliably inferred from the seasonal climate forecasts. However, discounting the potential for major fires during the spring would be a serious mistake.

Vegetation types that are grass dominated or that grow on thin or sandy soils respond to even short-duration drying, and are prone to burn aggressively in otherwise normal periods. Though the areas of concern represented by the aforementioned vegetation types (located largely in Cape Cod, Long Island, the New Jersey Pine Barrens, the Delaware-Maryland-Virginia peninsula, and the northern Great Lakes) account for less than 10 percent of the total acreage in the eastern area, they are interspersed with widespread wildland-urban interface communities.

Climate and Weather Outlook

The El Niño-Southern Oscillation (ENSO) through

the first part of the winter of 2005–2006 transitioned from a weak El Niño state into a weak La Niña state, and will likely remain in a weak La Niña state through the remainder of the winter season. Historically, weak-to-neutral La Niña climatic impacts during this outlook period are uncertain across the Eastern Area. Climate forecasts for the late winter and early spring (February through April) of 2006 project a 33.0–39.9 percent chance of above-average temperatures across much of the Mid-Atlantic states, with the highest chances of above-average temperatures (40.0–49.9 percent) over a region encompassing eastern Virginia, southwestern Pennsylvania, Maryland and northern Virginia. Increase chances of above-average precipitation from February through May were forecast for the southeastern Big Rivers and western half of the Mid-Atlantic states. A 33.0–39.9 percent chance of below-average precipitation is forecast for the western Big Rivers for February through May.

Fire Occurrence and Resource Outlooks

Historically the Eastern Area does not import large amounts of resources. However, based upon current information the spring 2006 fire season across portions of the Great Lakes could begin earlier than normal due to the below-average snow depths that were in place over parts of this compact towards the end of January (Figure 12, page 38). If these below-average snow depths are not alleviated through the remainder of the winter months, grasses will not be compressed and will remain standing. These fine fuels will then be readily available for ignition after snow melt and may create a higher resource need if any periods of high fire danger occur before green-up. Fires in the peat soil areas may also be very problematic if springtime rainfall events/amounts are minimal.

The southwestern portion and parts of the northern and western Big Rivers may also experience an earlier start to their fire season based on current precipitation and soil moisture anomalies in place towards the end of January. These anomalies directly affect the finer fuels which carry fire in these areas.

Due to significant hurricane activity during the 2005 season, Eastern Area resources have assisted with recovery efforts in the Southern Area. Along with national

wildland fire incidents, response to hurricane assignments has continued throughout the winter.

Summary and Recommendations

Most of the Great Lakes region entered into the winter months with fuel moistures at average to above-average levels (Figure 13, page 38). If snow cover remains minimal through the rest of the winter, fuels will likely be somewhat drier than normal by spring. Cured grasses, which are usually compacted by winter snowfall, are still standing upright. Increased fire behavior can be expected if grasses remain standing into the spring months.

If moist conditions do occur during the spring months as the current outlook depicts, a late start to the fire season with low fire occurrence is expected. However, if the current trend continues with little precipitation and warmer-than-normal temperatures, then an early start to the fire season—possibly by mid-March—is expected, with more frequent fire occurrence and more active fire behavior.

Based upon the most recent fuels and longer-term climate forecasts available, the spring fire season forecast is below-normal large fire potential for the northwestern half of the Mid-Atlantic Compact and normal for the southeastern half (Figure 8, page 36). Periods of fire activity are expected (relative to historical occurrence trends) through the spring fire season. It is difficult to assess fuel conditions at this early date, but the spring fire season in the Mid-Atlantic Compact is driven by fine dead fuels and the factors that influence them. Areas of the compact have experienced fine fuels buildup resulting from periods of above-average precipitation events during 2005. These fine fuels loadings will provide good continuity for ignitions, given any short term dry periods during the fall of 2006. However, with wetter-than-normal conditions expected over the northwestern half of the Mid-Atlantic Compact, below-normal large fire potential is anticipated during spring 2006.

Below-average snow depths were in place over portions of the northern Mid-Atlantic states (Figure 12, page 38). This may create an earlier-than-normal start to the 2006 spring fire season. It is important to acknowledge that several days to a week of moderate to high fire danger can create fuel conditions that may produce an episode of fires or a major fire, particularly in areas of sandy soils.

For New England and New York, there is an equal chance of normal precipitation and normal

temperatures for the spring fire season. Although winter precipitation is normal to above average (Figure 10, page 37), snowpack is lacking (Figure 12, page 38). This may result in an earlier start to the spring fire season. Given near-normal weather conditions, the compact area can expect normal to below-normal fire activity.

With equal chances of above- or below-average precipitation forecast for the Big Rivers, the region has been placed in above-normal large fire potential for spring 2006. An earlier-than-normal spring fire season is also anticipated.

Southern Area

The Southern Area is currently experiencing significant fire activity. January month to date (January 18, 2006) occurrence statistics show that although the area as a whole is within the high end of the average range for numbers of fires (roughly 2,160), the acreage burned is about 10 times the average number reported for the last 18 years. The majority of this activity has been centered in Texas and Oklahoma, where the recurring gusty wind conditions have resulted in dramatic acreage increases. In addition, the widespread activity has often involved wildland-urban interface areas, with numerous structure losses.

Currently, fire-fighting resources are being devoted to fire suppression activities in Oklahoma and Texas, as well as to clean up activities from hurricanes Katrina, Rita, and Wilma. There is a strong probability for fire conditions to persist through Texas and Oklahoma and increase in Florida, further straining resources.

Current Conditions

As the Southern Area enters January 2006, the drought west of the Mississippi River Valley, which started around April 2005, continues to persist (Figure 10, page 37). Precipitation deficits for the last 365 days range from 10–12 inches below average across areas of central Oklahoma and Texas to near 20 inches below average over Arkansas, Louisiana, and Texas. This puts these areas in widespread moderate to extreme or exceptional agricultural and hydrological drought. Recently, the weather pattern has produced more rain activity (albeit light and isolated) for areas of eastern Oklahoma and Texas; Arkansas and Louisiana are also beginning to see more precipitation activity.

The Arkansas and Louisiana area is, in general, a transition area between the extreme drought conditions to the west and the near-average to slightly below-average



conditions present in the eastern third of the Southern Area, where precipitation amounts and precipitation frequency have been much higher.

With the exception of the area west of the Mississippi River Valley and south-central Florida, fuel moistures are generally within average ranges. Large fuels (1,000-hour fuels) in Texas and Oklahoma have reached critical thresholds (Figure 13, page 38). Fall 2005 hurricane activity over south Florida and the central Gulf Coast produced a significant increase in the amount of dead and/or downed fuels, especially in areas of Wildland-Urban Interface. Activities to mitigate the impacts of fuel build-up are ongoing and will most likely continue for the foreseeable future. Any emerging drought over the central Gulf Coast will have significant fire danger and resource implications. Given the outlook for an active hurricane season in 2006, any storms making landfall will likely add to or expand the existing hazardous fuels areas.

Climate and Weather Outlooks

The seasonal outlook from the NOAA Climate Prediction Center is dominated by La Niña-like conditions across much of the Southeast despite current ENSO conditions only tending toward the cold side of neutral Pacific Ocean sea surface temperatures. A weak La Niña, coupled with other reinforcing patterns, such as the negative phase of the Pacific-North American (PNA) index or positive phase of the North Atlantic Oscillation (NAO) index, support a forecast of La Niña-type conditions during the early part of the forecast period. Conditions tend toward more average probabilities later in the forecast period.

February–April

Much of the Southeast can expect near-average temperatures with the exception of Texas and western Oklahoma, where warmer-than-normal conditions are expected. Precipitation forecasts show a tendency toward La Niña-like conditions, with the southeastern coastal plain along with Texas and Oklahoma showing drier-than-normal conditions probable while the Tennessee and Ohio river valleys show increased potential for wetter-than-normal conditions.

March–May

Increased probabilities of warmer-than-normal conditions are expected to persist in Texas, and the Florida peninsula will also tend toward increased probabilities of warmer-than-normal conditions. Increased probabilities of continued dry conditions through Florida and

the southeastern coastal plain are forecast, while forecasts indicate equal chances of dry, normal, and wet conditions in Texas. Increased probabilities of wetter-than-normal conditions are forecast for the Ohio River Valley.

April–June

Increased probabilities of warmer-than-normal conditions are forecast across Florida and Texas. Equal chances of dry, normal, and wet conditions are forecast across the region for this period. These forecasts are probably due to persistent ocean-atmosphere conditions for much of the region, except in Florida where the shift from increased probabilities of drier-than-normal conditions to equal chances is the result of tropical moisture building across the region during June, increasing the chance of rain late in the forecast period.

May–July

Increased probabilities of warmer-than-normal conditions expand across much of the Gulf Coast. The precipitation outlook is strongly influenced by the likelihood of increased tropical moisture during June and July, related to potential for an active tropical storm season.

Fire Occurrence and Resource Outlooks

- Texas, Oklahoma, and Florida are already experiencing above-normal fire occurrence.
- The majority of ignitions are human caused.
- If drought conditions develop as expected in Florida, a severe wildfire outbreak is likely at the start of the lightning season in late April/early May.
- Resources across the region are already stretched thin with significant commitments to fires in Texas and Oklahoma and continued commitments to hurricane clean-up.

Future Scenarios and Probabilities

Most Likely Scenario

With ENSO conditions on the cold side of neutral we can expect a predominance of La Niña-like conditions, as teleconnections patterns like the PNA and NAO produce occasional periods that reinforce the northward shift in the storm track favored by La Niña. This northward storm track shift will limit the number of frontal systems capable of delivering significant rainfall to the southern tier of the country. Under these conditions, drought is expected to persist across Texas and Oklahoma, while drought conditions begin to develop throughout the Florida peninsula. Since the PNA and

NAO predominantly influence wintertime conditions, their influence should fade through the March–May period. Tropical moisture is expected to build across the region in anticipation of another active hurricane season.

Worst Case Scenario

Sea surface temperature anomalies in the tropical Pacific continue to become increasingly negative leading to a fully developed La Niña pattern. Under these conditions, the PNA and NAO patterns will have less influence as the northward shift in the storm track becomes more firmly established. A well-established La Niña episode would favor drying conditions throughout the southeastern coastal plain, increasing the possibility of elevated fire danger levels in hurricane stricken areas.

Best Case Scenario

Sea surface temperature anomalies tend toward the warm side of neutral, removing the northward bias to the storm track. Under these conditions, drought across the southern tier of the country becomes less likely as more frontal systems will be capable of delivering moisture to these regions. While some fire episodes will occur across the region, no long-term wide spread regions of high fire danger would be expected.

Management Implications

Currently resources are heavily involved in fire suppression activities in Oklahoma and Texas as well as clean up activities from hurricanes Katrina, Rita, and Wilma. There is a strong probability for fire conditions to persist through Texas and Oklahoma and increasing in Florida, further straining resources.

Summary and Recommendations

- Texas and Oklahoma are experiencing extreme drought and high fire activity with resources from all southern states involved in fire suppression activities.
- Fire activity is increasing in Florida as drought conditions are developing.
- La Niña-like conditions in the tropical Pacific will contribute to further drying across the southeastern coastal plain, providing little relief.
- A northward shift in the storm track will bring enhanced precipitation to the Ohio and Tennessee river valleys, reducing fire danger in these areas.
- Tropical moisture is likely to bring an end to the fire season in Florida by mid-June.

Southwest Area

For a complete report of southwestern fire potential, please refer to the Southwestern Geographic Area report in the Western States and Alaska section (page 13). The overall 2006 Southwest Area fire season will be above normal in terms of the Geographic Area's impact on national firefighting resources. This will be characterized by an early and active season in all fuel regimes across most of the geographic area, with above-normal potential for initial attack and large fire development. The potential for early season timber fires will be particularly high due to the following factors.

- Abundance of carryover fine herbaceous fuels from the wet 2004–2005 winter;
- Significant precipitation deficit since the weak 2005 monsoon and nearly nonexistent mountain snowpack;
- Forecast of continued warm and dry conditions through May;
- Lower elevation, lighter fuel types susceptible to fire through the winter;
- Mid- to high-elevation, heavier fuel types to support significant fire activity by April;
- Moisture to increase east of the Continental Divide by late May/early June;
- Monsoon expected to begin early or on time and provide ample rainfall;
- Fire activity to remain significant into July, mainly west of the Continental Divide.

Possible preparedness efforts

The following are considerations for fire management interests in light of the developing nature of the upcoming fire season.

- Bring on seasonal resources early and complete training and preparedness/safety reviews as early as possible.
- Pre-position additional aviation and initial attack resources as early as March.
- Ensure firefighting personnel are aware that significant fire activity will continue in the fine fuels as in 2005, but that fires will have the potential to advance much more readily into the brush and timber fuels.
- Ensure National Fire Danger Rating System (NFDRS) pocketcards are updated and certified.



- Ensure all NFDRS stations are entering timely and accurate daily observations and otherwise functioning to NFDRS standards by February 1, 2006.

Fire activity assessment

- In terms of current and forecast conditions, 1996 is the most similar to what we expect in 2006.
- The 1995–1996 winter precipitation pattern was similar to what’s occurring now, and the previous year was fairly wet.
- 1996 had a dry windy spring, with significant large fire activity* in timber fuel types in April and May.
- More than 5,800 fires and 350,000 acres were burned during 1996, the bulk of which occurred prior to July 1.

- The first three months (January–March) of 1996 had several large fires, ranging from 250 to 10,000 acres.
- 1996 had 21 large fires which required one or more Type I or II Incident Management Team be assigned, compared to the average of 14.
- The amount of carryover fine herbaceous fuels was less in 1996 than it is now in early 2006.
- 2006 is shaping up to be a very active, early, and intense fire season, on the scope of what occurred from January through June 1996.

**Dome: 16,774 acres and Hondo: 7,651 acres*

4. Conclusions and Recommendations

Eastern, Southern, and Southwestern Fire Season 2006

A number of discussions regarding forecast tools, fuel conditions, and climate impacts were contributing factors to the success of the 2006 National Seasonal Assessment Workshop. Significant wildland fire activity in Texas, Oklahoma, and Arkansas helped increase awareness for all contributors to the workshop, especially those in the vulnerable southern tier of the United States. Climate forecast discussions, led by NOAA Climate Prediction Center Forecast Chief Ed O'Lenic enhanced enthusiasm for the use of NOAA forecast products. O'Lenic's clearly expressed presentation paved the way for a better understanding of the strengths and weaknesses of seasonal climate outlooks, and the deeper dialogues about the use of climate forecasts for fire potential predictions. Northeast Regional Climate Center Climatologist Dan Graybeal, Southeast Climate Consortium Climatologist David Zierden, and CLIMAS Program Manager Gregg Garfin made presentations on teleconnections and multi-decade persistence in the ocean-atmosphere system. Suggestions for improving future workshops were also solicited.

Participant Key Recommendations

- A suggestion to split the fire potential map, by season, into separate February–April and April–June maps, plus a summary map for the overall season. This would help distinguish between fire season forecasts for the Southern Area in February–April and fire season forecasts for the eastern and southwestern areas in April–June.
- Participants requested help from the NOAA Regional Climate Centers regarding a rigorous diagnosis of previous year climate and weather patterns, and an analysis of climate trends going into the early winter.
- Participants also recommended a summary of previous year fire activity and associated climate or weather patterns.



5. Figures

Eastern, Southern, and Southwestern Fire Season 2006

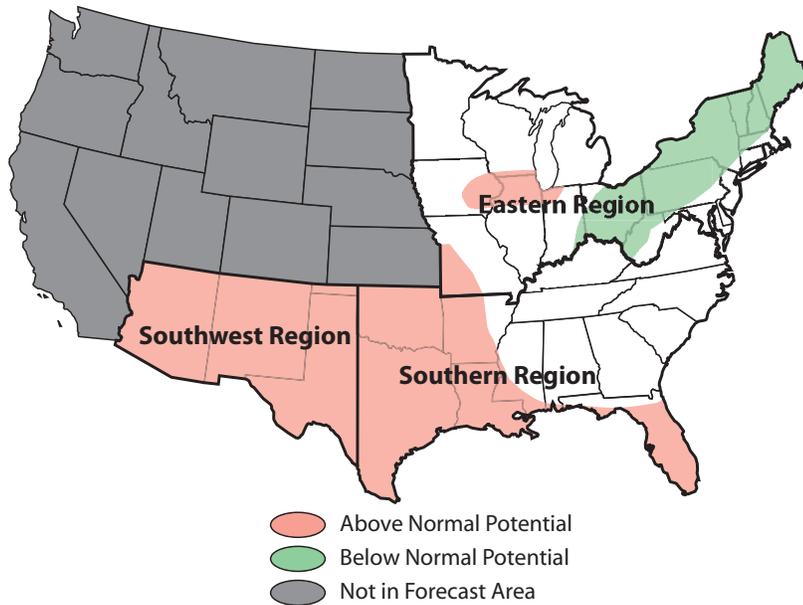


Figure 8. Outlook for significant fire potential for the Eastern, Southern, and Southwest Geographic Areas for February through June 2006.

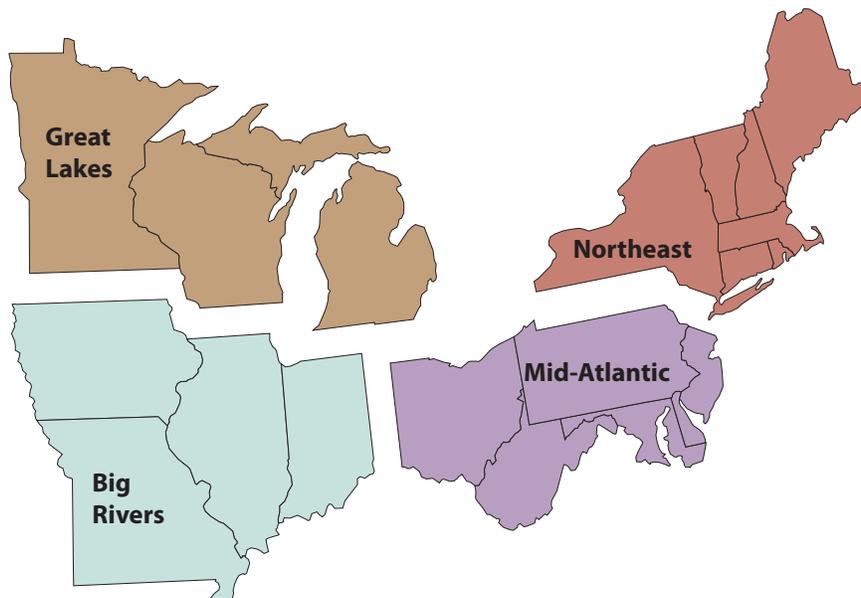


Figure 9. The Eastern Geographic Area is split into four compact areas, as shown above.

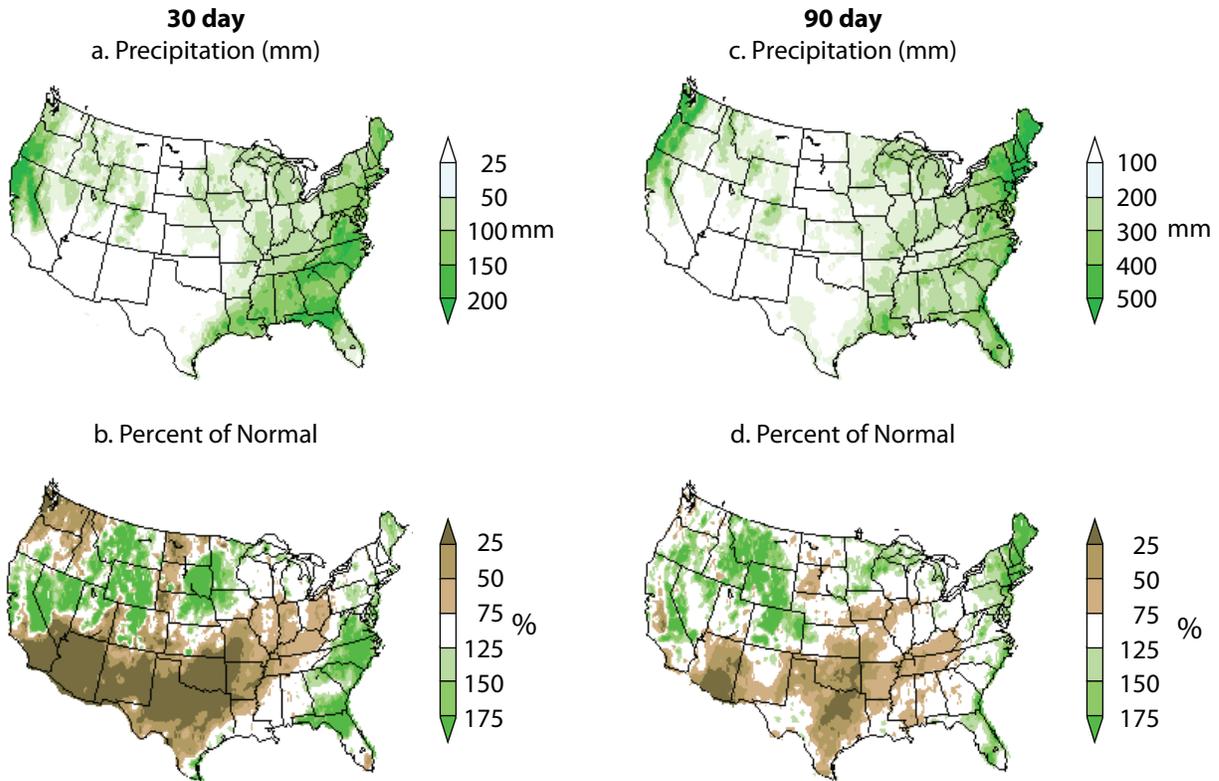


Figure 10. Accumulated precipitation for the 30-day (left) and 90-day (right) periods ending December 19, 2005. The topmost figures show actual total precipitation for the period of interest. The bottom figures show precipitation as a percent of normal. Source: NOAA Climate Prediction Center (CPC).

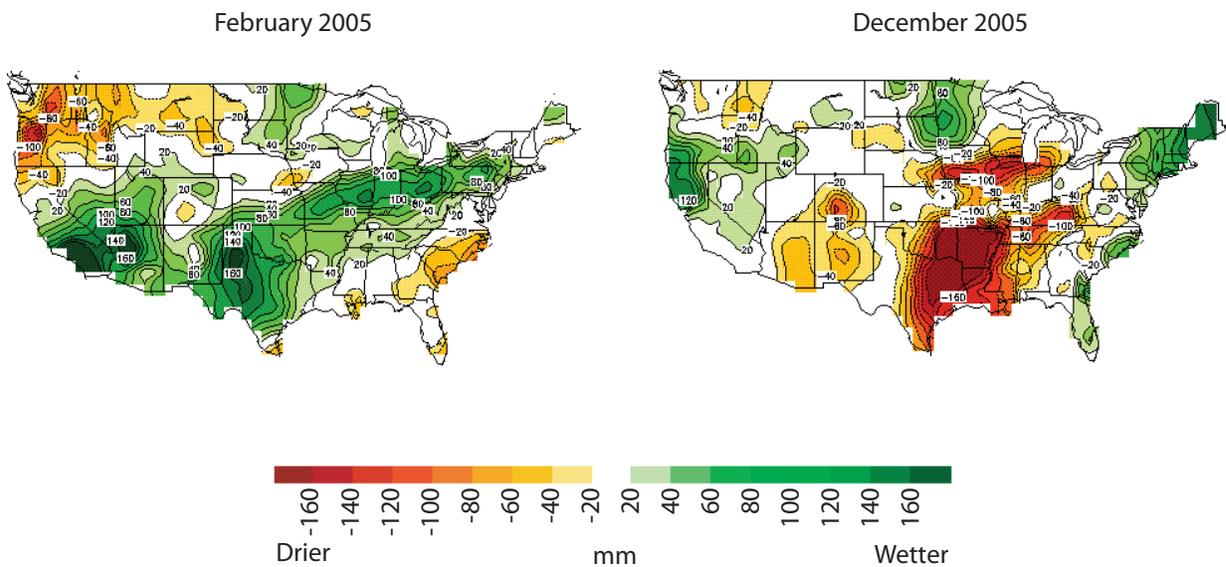


Figure 11. Soil moisture departures from the 1971–2000 average for the 12-month period ending in February 2005 and December 2005. The scale shows the difference, in millimeters of soil moisture in the top 1.6 meters of soil, for the previous 12 months compared to the 30-year mean. Source: NOAA CPC.

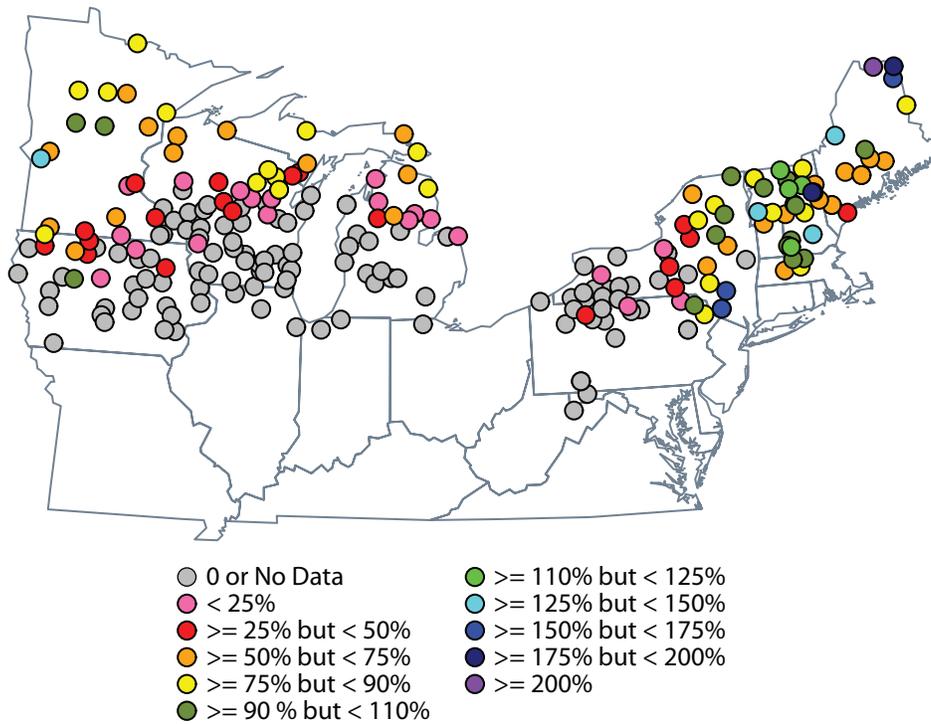


Figure 12. Dots show the percent of average snow depth as of January 10, 2006 compared to the 30-year climatological average (1971–2000). This is an experimental product. Source: Dan Graybeal, Northeast Regional Climate Center.

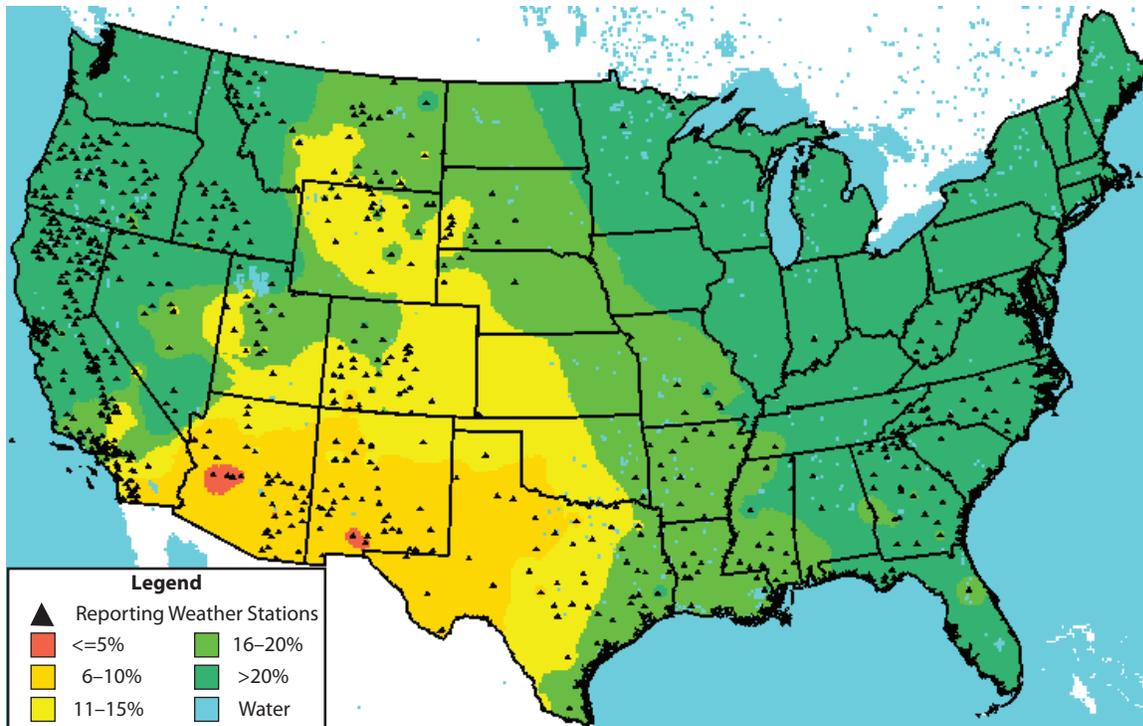


Figure 13. Observed 1,000 hour fuel moisture percentage as of January 12, 2006. Source: USDA Forest Service Wildland Fire Assessment System

Appendices

Eastern, Southern, and Southwestern Fire Season 2006

Appendix A: Agenda

January 18–20, 2006
National Conservation Training Center
Shepherdstown, West Virginia

		Attendees
Wednesday, January 18, 2006		
8:00–9:00 a.m.	Fuels discussion <i>Robyn Heffernan, NICC (moderator)</i>	All
9:00–10:00 a.m.	NOAA's Climate Forecast System (CFS) <i>Ed O'Lenic NOAA Climate Prediction Center</i>	Climate/Mets
10:00–11:30 a.m.	Teleconnections (ENSO, NAO/AO, AMO) <i>David Zierden (COAPS), Dan Graybeal (NERCC), Gregg Garfin (CLIMAS)</i>	Climate/Mets
9:00–10:30 a.m.	CHEETAH <i>Tom Wordell, NICC</i>	Intel/Fuels
10:30–11:30 a.m.	Preparation	Intel/Fuels
11:30 a.m.–12:30 p.m.	Lunch	
12:30–2:00 p.m.	CPC Forecast Discussion <i>Ed O'Lenic NOAA Climate Prediction Center</i>	All
2:00–5:00 p.m.	Breakout Work Sessions by Geographic Area	All
5:00 p.m.	Dinner	
Thursday, January 19, 2006		
8:00 a.m.–12:00 p.m.	Breakout Work Sessions by Geographic Area	All
12:00–1:00 p.m.	Lunch	
1:00–5:00 p.m.	Breakout Work Sessions	All
5:00 p.m.	Dinner	
Friday, January 20, 2006		
8:00–10:00 a.m.	Presentations <i>Final Outlook Reports and Presentations</i> <i>Delivery of presentations to the group on findings and conclusions</i>	All
10:00–10:30 a.m.	Feedback	All
10:30 a.m.–5:00 p.m.	Complete outlook write-up or travel	All



Appendix B: Participants List

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Reference Websites

CEFA

<http://www.cefa.dri.edu/>

CLIMAS: NSAW workshop proceedings

<http://www.ispe.arizona.edu/climas/conferences/NSAW/publications.html>

NOAA CPC: data sets for downscaling**Temperature**

<http://www.cpc.ncep.noaa.gov/pacdir/NFORdir/HUGEdir2/cd102t.dat>

Precipitation

<http://www.cpc.ncep.noaa.gov/pacdir/NFORdir/HUGEdir2/cd102p.dat>

DRI: Remote Access Weather Station

<http://www.raws.dri.edu/index.html>

**Scripps Institution of Oceanography
ECPC forecasts**

<http://ecpc.ucsd.edu/ecpc.html>

IRI: 2006 forecast archives

http://iri.columbia.edu/climate/forecast/net_asmt/2006/index.html

**USDA Forest Service: Wildland Fire
Assessment System**

<http://www.wfas.net/>

NCEP: NCAR reanalysis

<http://www.cdc.noaa.gov/cgi-bin/Composites/printpage.pl>

NICC Predictive Services

<http://www.nifc.gov/nicc/predictive/predictive.htm>

**Tall Timbers: bibliography on
wildland fire**

<http://www.talltimbers.org/info/fedbintro.htm>

WALTER: bibliography on wildland fire

<http://walter.arizona.edu/search/bibliography/index.asp>



Figure Websites

Figure 3: Temperature and Precipitation Forecasts

http://www.cpc.ncep.noaa.gov/products/predictions/long_range/two_class.html

Figure 4: Precipitation and Temperature Maps

<http://www.hprcc.unl.edu/products/current.html>

Figure 5a: United States Drought Monitor

<http://www.drought.unl.edu/dm/monitor.html>

Figure 5b: Standardized Precipitation Index

<http://www.wrcc.dri.edu/spi/spi.html>

Figure 6: Snowpack Map

<http://www.wcc.nrcs.usda.gov/snow/>

Figure 7: Greenness Map

<http://www.wfas.us/content/view/30/47/>

Figure 10: Precipitation Accumulation

http://www.cpc.ncep.noaa.gov/cgi-bin/anom_realtime.sh

Figure 11: Soil Moisture Anomaly

<http://www.cpc.ncep.noaa.gov/soilmst/w.shtml>

Figure 13: 1,000-hour Fuel Moisture

<http://www.wfas.us/content/view/23/38/>